



Atty. Docket No.: 025821.P031

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the application of:)
Steve Wai Leung Yeung)
Serial No.: 09/821,387)
Assigned Filing Date: March 28, 2001)
For: A DRIVING SCHEME FOR LIQUID CRYSTAL DISPLAYS)

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Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

Submitted herewith is a document upon which Applicant respectfully requests a convention priority for the above-captioned application, namely British Patent Application No. 00-07521.8 filed March 28, 2000 and British Patent Application No. 00-10979.3 filed May 5, 2000.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

Dated: 4/25/01 By: _____

Eric S. Hyman, Reg. No. 30,139

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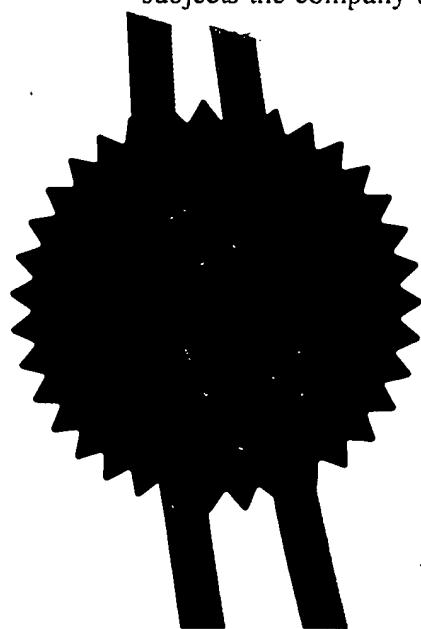
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1. Your reference

P15296

29MAR00 E525290-3 D00034
P01/7700 0.00-0007521.8**0007521.8**

28 MAR 2000

2. Patent application number

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3. Full name, address and postcode of the or of each applicant (underline all surnames)

1) VARINTELLIGENT (BVI) LIMITED 6667612001
CRAIGMUIR CHAMBERS
P.O. BOX NO. 71, ROAD TOWN, TORTOLA,
BRITISH VIRGIN ISLANDS.

Patents ADP number (if you know it)

2) TERENCE LESLIE JOHNSON 7864630001
C/O EDWARD EVANS & CO.
CLIFFORD'S INN, FETTER LANE,
LONDON, EC4A 1 BX, UNITED KINGDOM

1) BRITISH VIRGIN ISLANDS

4. Title of the invention

A DRIVING SCHEME FOR LIQUID CRYSTAL DISPLAYS
TO REDUCE FLICKERING IN SMALL PIXEL DISPLAYS

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom
to which all correspondence should be sent
(including the postcode)Edward Evans & Co.
Clifford's Inn
Fetter Lane
London EC4A 1BX

Patents ADP number (if you know it) 661002

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Country Priority application number
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A DRIVING SCHEME FOR LIQUID CRYSTAL DISPLAYS
TO REDUCE FLICKERING IN SMALL PIXEL DISPLAYS

Flickering is a common phenomenon in liquid crystal display. In passively driven liquid crystal display, flickering can be caused by the too fast response of liquid crystal such that it responses to time waveform instead of root-mean-square value. It might also be caused by charge imbalance among the substrates when frame inversion scheme is adopted to avoid net DC. In actively driven liquid crystal display, flickering is usually caused by the latter, i.e., charge imbalance. The reason is that the implantation of transistors is carried out on only one of the two surfaces of the substrates. To minimizing the perception of flickering in actively driven liquid crystal display, row and column inversions have been proposed. The flickering effect is thus spatially averaged out to an extent that is imperceptible. However, the method results in reduced contrast due to fringe field effect occurring on the pixel boundary. The loss is negligible when the pixel size is not too small. However, in case of miniature display (e.g., amorphous-silicon TFT, poly-silicon TFT, and miniature liquid crystal on silicon), the loss in contrast can be severe and cannot be overseen.

According to the present invention, there is provided a multi-column/row inversion driving method which reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering, the number of inversions per total number of scan lines being adjusted to strike a balance between contrast and perceptibility of flickering.

Thus, the invention is related to passively and actively driven liquid crystal display, or more particularly to the driving of the said display to minimize perception of flickering effect to observer.

Fig. 1 shows the structure of a passively driven liquid crystal display. Polarizers are attached on the outside of the glass substrate 1. The inner side of the glass substrates 1 is coated with conductive Indium Tin Oxide (ITO) film 2 whereon polyimide film or coating 3 is applied for alignment of the liquid crystal molecules. An enclosure between the glass substrates is formed by a seal in the form of an epoxy glue or seal 4 wherein liquid crystal is filled. The structure of the display is symmetrical with respect to a liquid crystal layer 5. Matrix addressing scheme is then applied to the ITO electrodes for addressing individual pixel formed by the intersection of the ITO lines. Frame inversion is adopted to avoid net DC applied to the liquid crystal. Fig. 2 shows an example waveform applied to the common and segment electrodes. In this arrangement, flickering effect may still exist due to the fact that liquid crystal molecules are usually not perfectly non-polar. In this case, flickering effect can be minimized by adopting a high enough frame frequency. In some occasions, the arrangement of the liquid crystal display is not symmetrical. Fig. 3 shows another arrangement such that underneath the polyimide coating a coating of silicon dioxide 8 is applied for the purpose of better electrical isolation between the two ITO surfaces. Fig. 4 shows another arrangement such that on the rear glass substrate/underneath the front a glass substrate colour filter 6 material is applied on/under the ITO layer. Yet another arrangement Fig. 5 shows that a reflective coating 7 is applied on/under the ITO layer of the rear substrate. All these arrangement results in loss of symmetry of the display that results in imbalance of charge built up among the substrates. The imbalance consequently results in net DC and different

effective signal waveform in two consecutive frames, which causes flickering. On the other hand, flickering is also observed in actually driven liquid crystal display where imbalance of charge is caused by the presence of colour filter, amorphous silicon TFT, poly silicon TFT, etc on one of the two glass substrates. In the case of reflective single crystal CMOS microdisplay, one of the glass substrates is replaced by silicon die, causing even higher degree of imbalance. Fig. 6 shows the arrangement for reflective single crystal CMOS microdisplay. To solve the flickering problem caused by imbalance of effective signal waveform, row/column inversion was proposed for actually driven liquid crystal display such that the flickering effect is spatially averaged out to an extent that is imperceptible. Fig. 7 and Fig. 8 show respectively the signal waveform incorporating row and column inversion schemes. For passively driven liquid crystal displays, row inversion can be adopted to minimize the perception of flickering. Fig. 9 shows the signal waveform incorporating row inversion. In all cases, the inversion method results in reduced contrast due to fringe field effect occurring on the pixel boundary. The loss is negligible when the pixel size is not too small. However, in case of miniature display (e.g., amorphous-silicon TFT, poly-silicon TFT, and reflective CMOS miniature display), the loss of contrast can be severe and cannot be overseen. Fig. 10 shows the 2D director configurations of two pixels of 15umx14um driven in column inversion mode. In the present invention, a multi-column/row inversion driving method is proposed which greatly reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering. The number of inversions per total number of scan lines can be adjusted to strike a balance between contrast and perceptibility of flickering. Fig. 11 shows the waveform with n -row inversion. Assuming that m is the number of scan lines. If $n=m$, we have conventional frame inversion. If $n=1$, we have single row inversion system. By increasing

perceptibility of flickering. Similarly, Fig. 12 and Fig. 13 show respectively the multi-row and multi-column inversion system for actively driven liquid crystal display. For reflective single crystal CMOS microdisplay, assuming pixel size 10um, single column inversion results in reduction of contrast by 30%. The reduction of contrast is kept below 5% by adopting 4-column inversion while at the same time flickering is imperceptible.

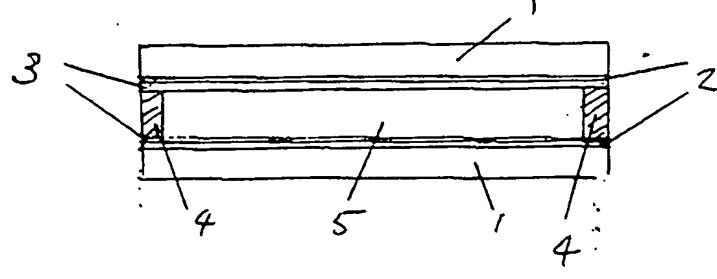
A method embodying the invention has the following advantage:

1. An n -column/row inversion driving method for liquid crystal display where n can be any integer from two to number of scan lines in case of row inversion and any integer from two to number of column lines in case of column inversion. The driving method greatly reduces total fringe field effect on display to maintain the contrast, yet minimizing perception of flickering. The number of inversions per total number of scan lines can be adjusted to strike a balance between contrast and perceptibility of flickering.
2. Referring to 1, the n -row inversion driving method that can be applied to passively and actively driven liquid crystal display where n can be any integer from two to number of scan lines.
3. Referring to 1, the n -column inversion driving method that can be applied to actively driven liquid crystal display where n can be any integer from two to number of column lines.

4. Referring to 1, 2 and 3, the inversion scheme is particularly advantageous to be adopted in actively driven miniature TFT and reflective liquid crystal on silicon displays.

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Fig. 1



1 - Glass substrate.

2 - ITO Coating

3 - Polyimide coating

4 - Epoxy seal

5 - Liquid Crystal layer

Fig. 2

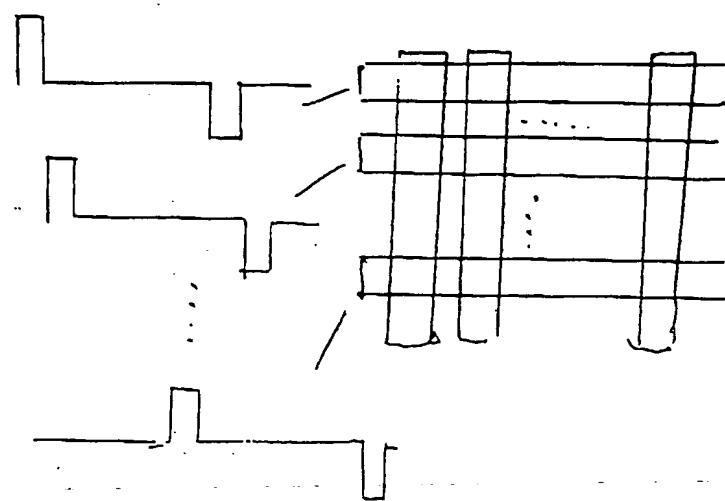
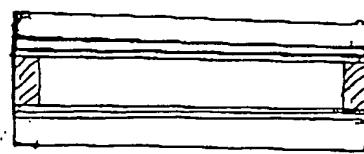
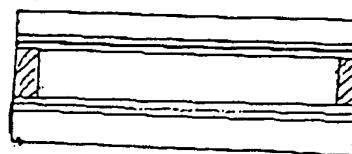
~~Fig. 3 / Fig. 4~~

Fig 4

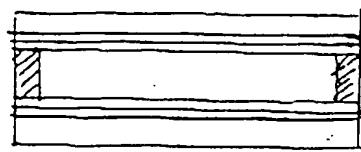


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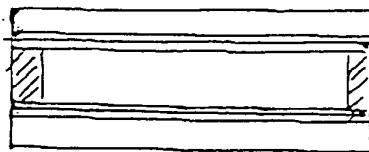


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6 - Color filter.



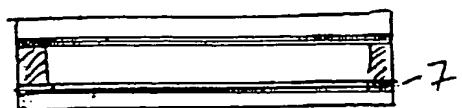
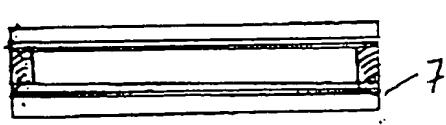
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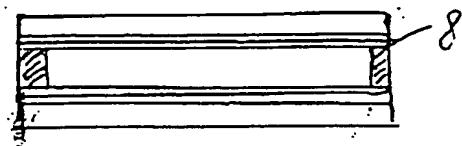
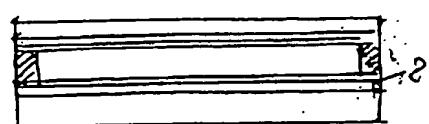
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Fig. 5.



7 - reflective
coating

Fig 3



8 - SiO₂
coating

Fig 6.

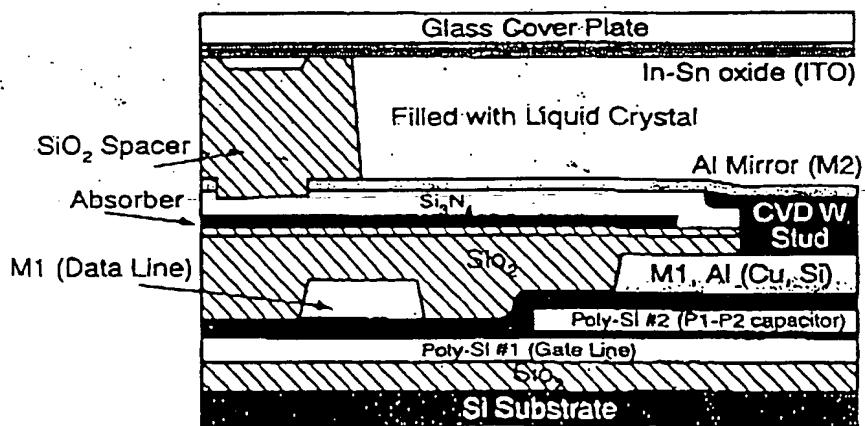
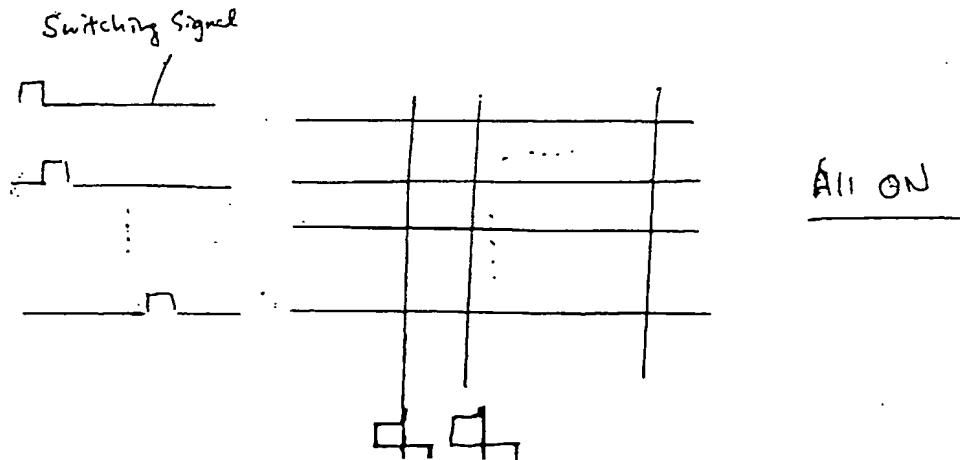
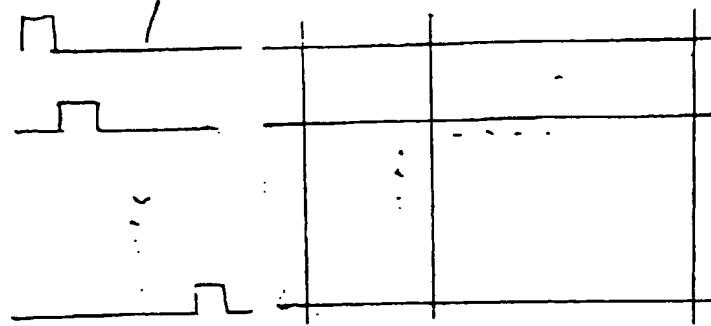


Fig 7.



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Switching Signal



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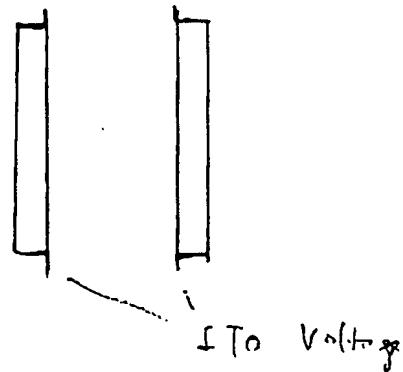
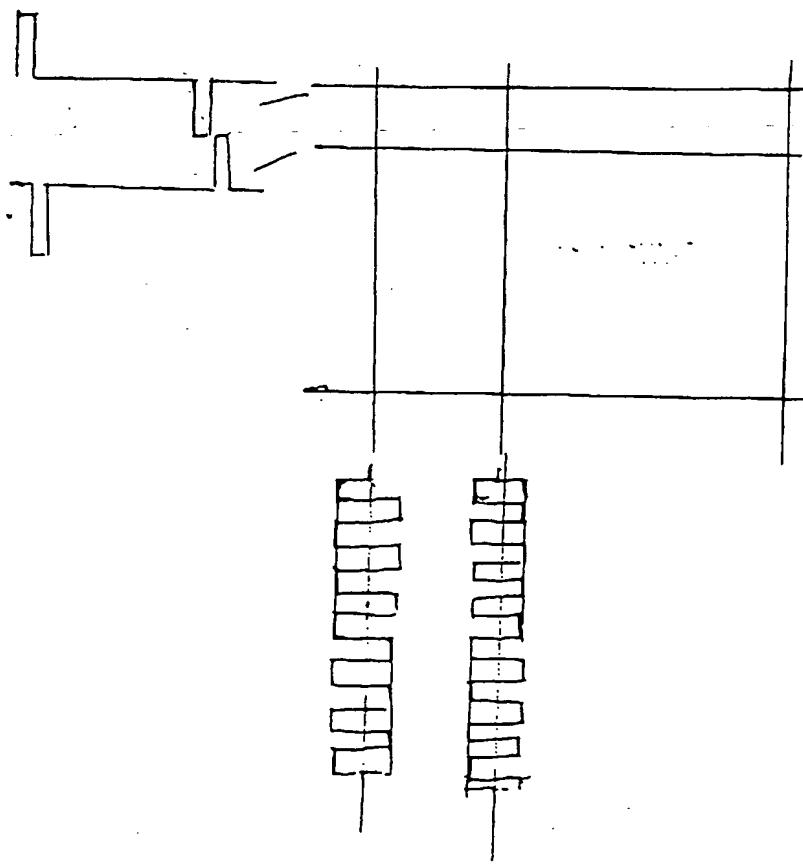


Fig 9.



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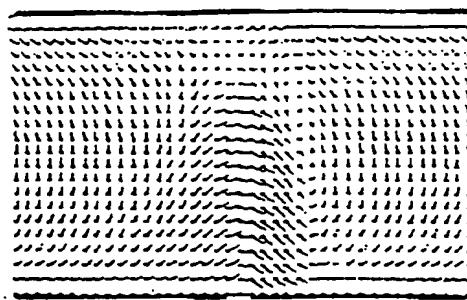
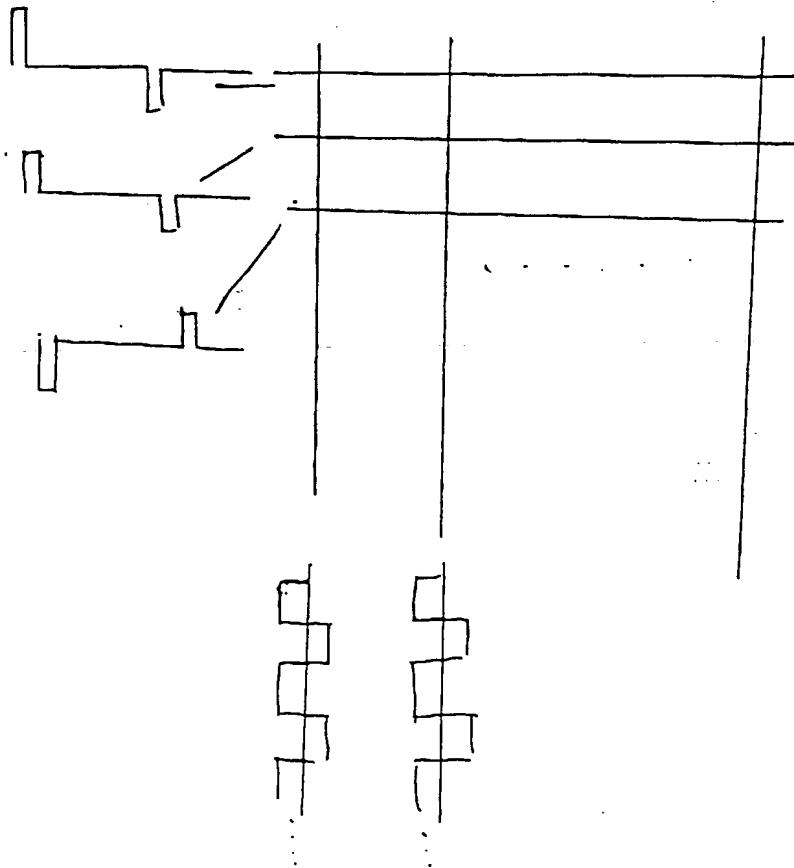


Figure 2 The 2D director configurations of two MTN pixels of $15\mu\text{m}$ in the column inversion.

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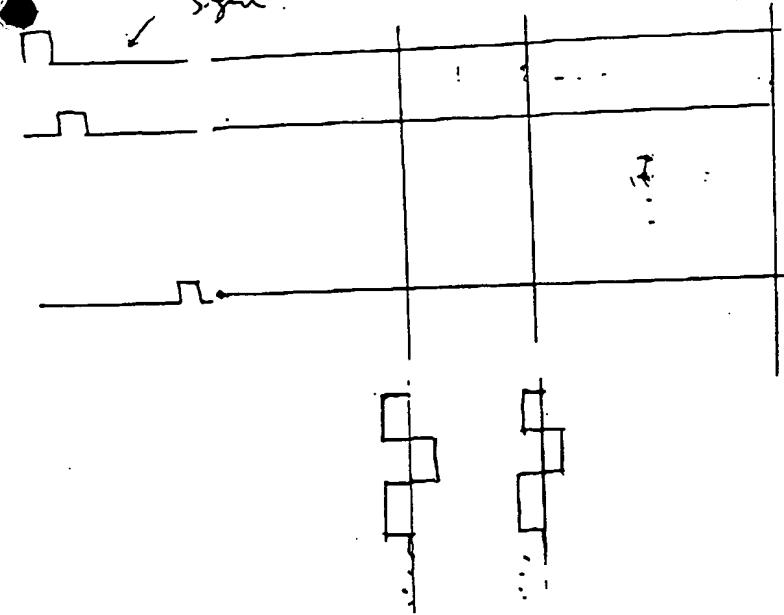


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2-row inversion

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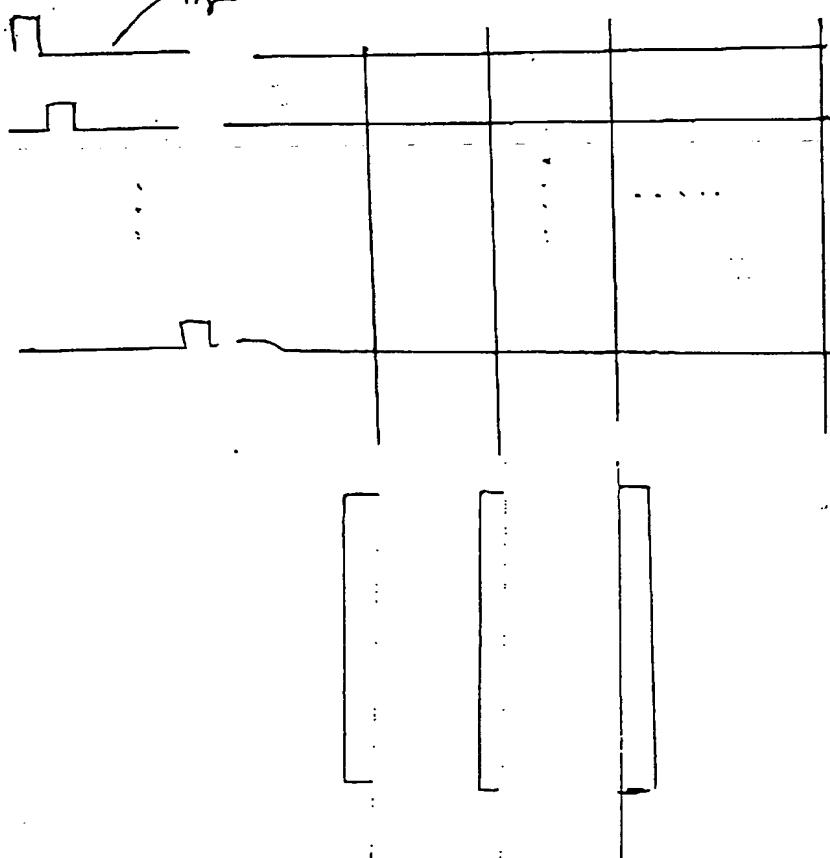
Fig. 12

Switching
signal

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2 - row invrs

Fig 13

Switching
signal

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2 - column invrs

I TO 45deg.

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